台灣農業研究 (J. Taiwan Agric. Res.) 62(4):289–299 (2013)
DOI: 10.6156/JTAR/2013.06204.01

A New Species of *Anagrus* (Hymenoptera: Mymaridae) from Tahiti, with Notes on Egg Parasitoids of Proconiine Sharpshooters (Hemiptera: Cicadellidae: Proconiini) in the World

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Abstract

Triapitsyn, S. V. 2013. A new species of *Anagrus* (Hymenoptera: Mymaridae) from Tahiti, with notes on egg parasitoids of proconiine sharpshooters (Hemiptera: Cicadellidae: Proconiini) in the world. J. Taiwan Agric. Res. 62(4):289–299.

One new fairyfly (Hymenoptera: Mymaridae) species, *Anagrus* (*Anagrus*) *iti* sp. n., described from Tahiti Island, French Polynesia, was reared from eggs of the invasive glassy-winged sharpshooter, *Homalodisca vitripennis* (Germar) (Hemiptera: Cicadellidae), which is native to southeastern USA and northeastern Mexico. An overview of the taxonomic and biological studies on the egg parasitoids (Hymenoptera: Aphelinidae, Mymaridae, and Trichogrammatidae) of various proconiine sharpshooters (Cicadellidae: Cicadellinae: Proconiini) in the New World is given. Of particular importance are the natural enemies of *H. vitripennis*, a notorious vector of the phytopathogenic bacterium, *Xylella fastidiosa*; with reference to its egg parasitoids and biological control in the non-native range are also provided.

Key words: Leafhopper, Proconiini, Egg parasitoid, *Anagrus*, Biological control.

INTRODUCTION

Proconiine sharpshooters belong to the New World cicadelline leafhopper tribe Proconiini (Hemiptera: Cicadellidae: Cicadellinae). The most notorious species is the glassy-winged sharpshooter, *Homalodisca vitripennis* (Germar 1821), a vector of plant diseases caused by the phytopathogenic bacterium, *Xylella fastidiosa* (Blua *et al.* 1999). The glassy-winged sharpshooter is a self-introduced pest in California from the southeastern USA where it is native; it is also native to northeastern Mexico (Triapitsyn & Phillips 2000). Turner & Pollard (1959) provided a brief overview of proconiine sharpshooter egg parasitoids (Hymenoptera: Mymaridae and Trichogrammatidae) in Georgia, USA. For a long time this was the only available publication on this group of natural enemies, which more recently has been shown to be amazingly diverse; almost every sharpshooter species has been found, upon closer examination, to have a complex of associated egg parasitoids. Establishment of *H. vitripennis* in California in the 1990s, later in the Hawaiian Islands and French Polynesia, and even more recently in Easter Island (Pilkington *et al.* 2005) prompted interest in proconiine sharpshooter investigations, including stud-

Received: July 30, 2013; Accepted: September 12, 2013.
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ies of their egg parasitoids in North America (Triapitsyn & Phillips 1996, 2000; Triapitsyn *et al.* 1998; Triapitsyn, Bezark *et al.* 2002; Triapitsyn, Hoddle *et al.* 2002), mainly for classical biological control purposes (Morgan *et al.* 2000, 2002; Triapitsyn & Hoddle 2001, 2002; Pilkington *et al.* 2004, 2005).

Grandgirard *et al.* (2007) conducted a thorough survey of the native egg parasitoids of the invasive *H. vitripennis* in French Polynesia; among them was an undescribed *Anagrus* sp. (Hymenoptera: Mymaridae) which was reared in Tahiti Island from an egg mass of the glassy-winged sharpshooter. It is described here as a new species, *A. iti*.

Due to the recent identification of *X. fastidiosa* in the vineyards of Taiwan (Su *et al.* 2013), which causes Pierce's disease of grapevines (the first such record in Asia), a summary of the known egg parasitoids in several families of Chalcidoidea (Hymenoptera) of the proconiine sharpshooter leafhoppers (its vectors) in the world is also given. Information on egg parasitoids of the leafhoppers from the tribe Cicadellini, also from the subfamily Cicadellinae, is scarce globally; these will be reviewed separately. Cicadellini contain several known vector species of *X. fastidiosa* in the USA and elsewhere; particularly, *Kolla paulula* (Walker 1858) is a potential vector of Pierce's disease of grapevine and a common cicadelline species in Taiwan (Shih *et al.* 2009; Su *et al.* 2013).

TAXONOMY: DESCRIPTION OF A NEW SPECIES OF MYMARIDAE

Anagrus (*Anagrus*) *iti* Triapitsyn, sp. n.

Anagrus sp.: Grandgirard *et al*. 2007: 183 (an undescribed species)

Type material. Holotype female on slide, deposited in the Entomology Research Museum, University of California, Riverside, California, USA (UCRC), labeled: (1) 'FRENCH POLYNESIA: Society Islands, Tahiti I.[sland], Tapahi Point, 11.i.2005, J. Grandgirard, reared from eggs of Glassy-winged Sharpshooter, *Homalodisca coagulata*, on hibiscus'; (2) 'Mounted at UCR/ERM by V. V. Berezovskiy 2005 in Canada balsam' (UCRC ENT 265298). Paratypes: 16 females and 4 males on points, and 1 female and 1 male on slides (UCRC), same data as the holotype.

Description. Female. Body length (dry-mounted paratypes) 0.46–0.66 mm. Body pale to yellowish except frenum of scutellum white, basal gastral terga and exserted part of ovipositor sheaths brown; scape, pedicel, and legs yellowish, flagellum brownish; wings hyaline. Head about as wide as mesosoma. Antenna (Fig. 1A) with scape 2.9–3.5 times as long as wide, with cross-ridges, 2.1 times length of pedicel; F1 cylindrical, about half of pedicel length; F2 longest of funicle segments; F3 slightly shorter, F4–F6 subequal in length; longitudinal sensilla on F3 (1), F4 (1); F5 (1 or 2), and F6 (2); clava with 5 longitudinal sensilla, slightly shorter than combined length of two preceding segments. Mesosoma shorter than metasoma (Fig. 1B). Midlobe of mesoscutum with a pair of adnotaular setae. Fore wing (Fig. 1C) 8.3–8.8 times as long as wide, longest marginal seta 1.9–2.5 times maximum wing width; distal macrochaeta 1.7–1.8 times length of proximal macrochaeta; disc, besides a row of setae along each margin, with a single complete median row of setae originating behind marginal vein and a few additional, scattered setae, mostly at apex. Hind wing 26–27 times as long as wide, longest marginal seta 6.2–6.6 times maximum wing width; disc mostly bare except for admarginal rows of setae. Ovipositor notably exserted beyond apex of gaster (by

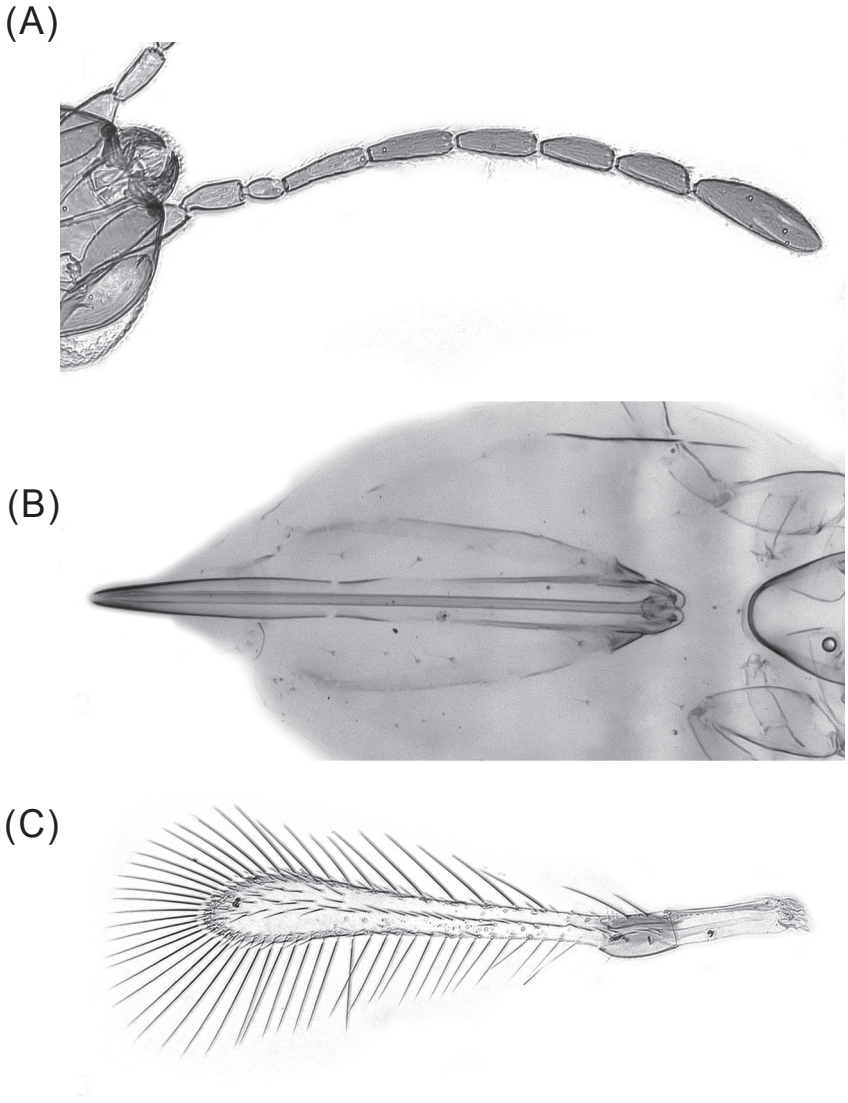

Fig. 1. *Anagrus* (*Anagrus*) *iti* (holotype female). (A) Antenna; (B) Metasoma; and (C) Fore wing.

0.15–0.16 times own length). External plates of ovipositor each with 3 distal setae. Ovipositor about 3.0 times length of protibia.

Measurements (mm) of the holotype female (as length or length : width). Body 0.805; head 0.154; mesosoma 0.258; gaster 0.406; ovipositor 0.375. A ntenna: scape 0.094; pedicel 0.045; F1 0.024; F2 0.066; F3 0.063; F4 0.058; F5 0.055; F6 0.056; clava 0.103. Fore wing 0.581: 0.07; longest marginal seta 0.133. Hind wing 0.56 : 0.021; longest marginal seta 0.13.

Male. Body length (dry-mounted paratypes) 0.43–0.56 mm. Similar to female except for the normal sexually dimorphic features such as antenna and genitalia (Fig. 2A), and the following. Body notably darker than in female, with head and most of mesonotum light brown and gaster almost entirely brown to dark brown; fore wing (Fig. 2B) about 7.5 times as

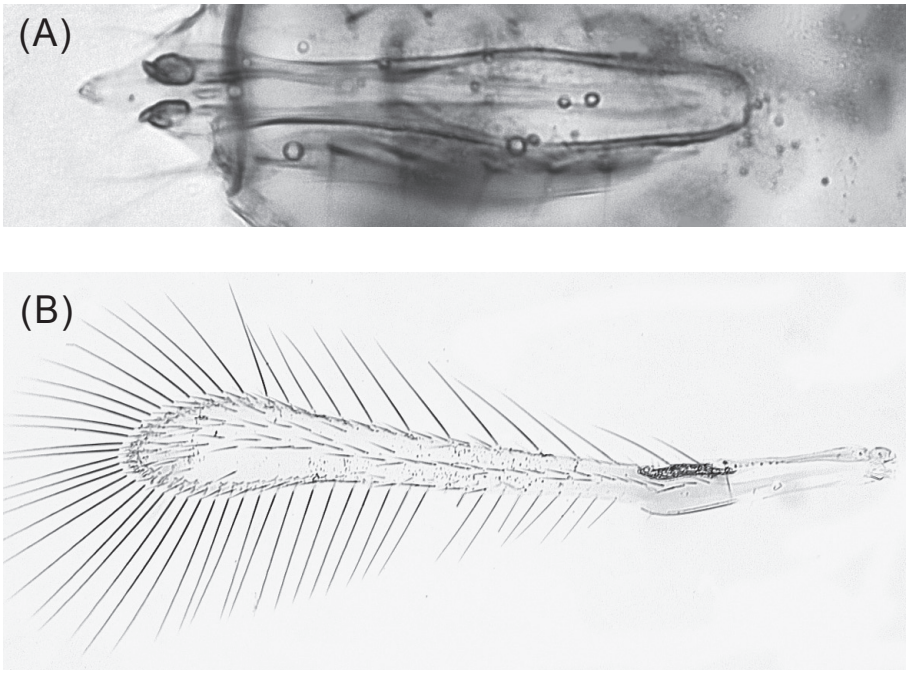

Fig. 2. *Anagrus* (*Anagrus*) *iti* (paratype male). (A) Genitalia and (B) Fore wing.

long as wide, relatively more setose than in female.

Diagnosis. The new species belongs to the *incarnatus* species group of the nominate subgenus of *Anagrus*, as defined by Chiappini *et al*. (1996). Morphologically, it is most similar to the Australasian species *A. antipodus* Triapitsyn, 2001 and also to *A. oahuensis* Triapitsyn and Beardsley, 2000 known from the Hawaiian Islands and Mexico (Triapitsyn & Beardsley 2000; Triapitsyn 2002a). *Anagrus iti* has a longitudinal sensillum on F3 of female antenna, which *A. antipodus* lacks (Triapitsyn 2001), and 3 distal setae on the external plate of the ovipositor whereas *A. oahuensis* has 2 such setae.

Etymology. The species name 'iti' means 'small' in Tahitian language, referring to the minute size of the parasitoid.

Host. The type series of this species (18 females and 5 males) was reportedly reared from one egg mass of *H. vitripennis* on *Scaevola* sp. (Goodeniaceae) containing 8 eggs (Grandgirard *et al*. 2007) [as *Anagrus* sp.], although hibiscus (*Hibiscus* sp.; Malvaceae) was indicated on the labels; it is uncertain which is the correct host plant, and they would not be confused with one another.

NOTES ON THE KNOWN EGG PARASITOIDS OF PROCONIINI IN THE WORLD

Aphelinidae

***Centrodora* Förster, 1878:** Species of this genus appear to be more polyphagous egg parasitoids of some Hemiptera and are very difficult to identify. The two species reared from eggs of Proconiini remain undetermined: one *Centrodora* sp. from Tahiti and Moorea Islands, French Polynesia is a parasitoid of the non-native *H. vitripennis* (Grandgirard *et al*. 2007); the other *Centrodora* sp. was reared in Argentina from eggs of *Tapajosa rubromargin-*

ata Signoret, 1855 and *Tretogonia notatifrons* Melichar, 1926 (unpublished data).

Mymaridae

***Acmopolynema* Ogloblin, 1946:** One species of this genus, *A. sema* Schauff, was reared in Florida and Georgia, USA, from eggs of *Homalodisca insolita* (Walker 1858) (Triapitsyn, Hoddle *et al*. 2002).

***Anagrus* Haliday, 1833:** Besides *A. iti* from Tahiti described as a new species here, three other species of this genus have been recorded as egg parasitoids of Proconiini in the New World: *A. epos* Girault, 1911 in Minnesota, USA, a gregarious parasitoid of *Cuerna fenestella* Hamilton, 1970 (Hoddle & Triapitsyn 2004; Triapitsyn 2006), which was mass-reared and released without much success in California against *H. vitripennis* (Krugner *et al*. 2009; CDFA 2013), where its host specificity and other biological traits were studied by Krugner *et al*. (2008); *A. stethynioides* Triapitsyn, 2002, an occasional and poorly known parasitoid of *H. vitripennis* in Texas, USA (Triapitsyn 2006); and *A. breviphragma* Soyka, 1956 from *Dechacona missionum* (Berg 1879) in Argentina (Luft Albarracin *et al*. 2009).

***Gonatocerus* Nees ab Esenbeck, 1834:** This large and common genus contains many species that are known as egg parasitoids of various Proconiini, including those used in the biological control program against *H. vitripennis* in California (Peña *et al*. 2010; CDFA 2013), as summarized by Triapitsyn (2006) for the Nearctic region and Triapitsyn *et al*. (2010) for the Neotropical region. Details on their diversity, taxonomy, host associations and other biological traits are therefore omitted for brevity: these are readily available and too numerous to fit in this communication. All are solitary egg parasitoids, producing one wasp per host egg, except for *G. fasciatus* Girault, 1911 which is a gregarious parasitoid (Triapitsyn *et al*. 2003). Biology of several species of *Gonatocerus* was thoroughly studied (Irvin & Hoddle, 2004, 2005a, 2005b; Virla *et al*. 2005; Son *et al*. 2012). They do not appear to be too host specific but rather are usually able to attack eggs of at least several genera and species of Proconiini (Boyd & Hoddle 2007; Logarzo *et al*. 2012; Lytle, Morse *et al*. 2012). All of them belong to the subgenus *G.* (*Cosmocomoidea* Howard 1908), which also contains a large number of undescribed species from Central and South America which are likely egg parasitoids of Proconiini (Triapitsyn 2002b; Triapitsyn *et al*. 2010), thus suggesting apparent co-evolution. Triapitsyn (2012) reported the following species of *Gonatocerus* from eggs of *H. vitripennis* in California: *G. ashmeadi* Girault, 1915, *G. fasciatus* (intentionally introduced), *G. incomptus* Huber, 1988, *G. morgani* Triapitsyn, 2006, *G. morrilli* (Howard 1908) (intentionally introduced), *G. novifasciatus* Girault, 1911, *G. triguttatus* Girault, 1916 (intentionally introduced), and *G. walkerjonesi* Triapitsyn, 2006. The southern and southeastern USA strains of *G. ashmeadi* were released in California against *H. vitripennis* (Morgan *et al*. 2002; Pilkington *et al*. 2005). *Gonatocerus ashmeadi* was found self-introduced in Oahu Island, Hawaii (USA), where it provides a good control of *H. vitripennis*; it was intentionally and successfully introduced into French Polynesia for very effective biological control against *H. vitripennis* (Grandgirard *et al*. 2008a, 2008b). It was also found self-introduced in Easter Island, Chile (Triapitsyn 2006). Paradell *et al*. (2012) summarized the known egg parasitoids of Proconiini in Argentina, the majority of which are *Gonatocerus* species described or revised taxonomically by Triapitsyn *et al*. (2006, 2007, 2008, 2010); *T. rubromarginata* is the most thoroughly studied host of many of these parasitoids.

***Palaeoneura* Waterhouse, 1915:** One undetermined species of this genus was reared in Tahiti Island from eggs of *H. vitripennis* (Grandgirard *et al*. 2007).

***Polynema* Haliday, 1833:** An undescribed species of *P.* (*Doriclytus*) sp. was reared in California, USA from eggs of *H. vitripennis*; it is only an occasional parasitoid of this host (Triapitsyn 2012). One or two other *P.* (*Doriclytus*) spp. were reared in Argentina from sentinel eggs of *T. rubromarginata* (G. A. Logarzo and S. V. Triapitsyn, unpublished).

Trichogrammatidae

Members of several genera are gregarious egg parasitoids of various Proconiini, all in the New World (Triapitsyn 2003); trichogrammatids are generally relatively more common on grassy vegetation and in dry habitats.

***Burksiella* De Santis, 1957:** *Burksiella spirita* (Girault 1918) is a common egg parasitoid of *H. vitripennis* and also of *Oncometopia orbona* (Fabricius 1798) in the southeastern USA (Triapitsyn 2003 [as *Zagella spirita* (Girault)], 2012); a related form, which may or may not belong to this species, was reared in Montana, USA, from eggs of *Cuerna sayi* Nielson, 1965 (Triapitsyn *et al*. 2011). One or two different, undetermined species *Burksiella* sp.(p) was/were reported from eggs of *Homalodisca liturata* Ball, 1901 in Mexico (Triapitsyn & Bernal 2009). *Burksiella platensis* (De Santis 1957) is known from eggs of *T. rubromarginata* in Argentina (Triapitsyn 2003).

***Ittys* Girault, 1911:** One undescribed species of this genus was reported from eggs of *H. liturata* in Mexico (Triapitsyn & Bernal 2009).

***Oligosita* Walker, 1851:** An *Oligosita* sp., possibly *O. americana* Girault, 1909, was reared in Georgia from eggs of *H. insolita* (Turner & Pollard 1959; Triapitsyn 2003). Undetermined *Oligosita* spp. were also reared from eggs of two species of Proconiini in Argentina (Paradell *et al*. 2012); at least one of these is, however, a member of *Pseudoligosita* Girault, 1913 (Triapitsyn & Bernal 2009).

***Paracentrobia* Howard, 1897:** *Paracentrobia acuminata* (Ashmead 1888) was reared in Florida and Georgia from eggs of *Cuerna costalis* (Fabricius 1803), *H. insolita*, and *H. vitripennis* (Turner and Pollard 1959; Triapitsyn 2003 [as *Paracentrobia* (*Brachistella*) sp.]; Tipping *et al*. 2005). Also *P. americana* (Girault 1917) is a parasitoid of *H. insolita* in Florida (Tipping *et al*. 2005). In Argentina, *P. tapajosae* Viggiani, 2009 is known from eggs of *T. rubromarginata* when Virla *et al*. (2009) studied biology of the parasitoids. Undetermined *Paracentrobia* spp. were also reared from eggs of three other species of Proconiini in Argentina (Paradell *et al*. 2012).

***Pseudoligosita*:** Two species of this genus were reared from eggs of Proconiini: *P. plebeia* (Perkins 1912) from *H. liturata* in Mexico [Triapitsyn & Bernal 2009 (as *Pseudoligosita* sp.); Triapitsyn 2012] and also from eggs of *T. rubromarginata* in Argentina (Triapitsyn & Bernal 2009); and an undetermined and apparently undescribed *Pseudoligosita* sp. from eggs of *H. vitripennis* in California (Triapitsyn 2012). Biological traits of *P. plebeia*, which was reared under quarantine conditions in California on eggs of *H. vitripennis*, were reported by Triapitsyn & Bernal (2009) and Lytle, Bernal *et al*. (2012).

***Ufens* Girault, 1911:** *Ufens ceratus* Owen, 2005 and *U. principalis* Owen, 2005 are common egg parasitoids of *H. liturata* and *H. vitripennis* in Mexico and USA (Al-Wahaibi *et al*. 2005; Triapitsyn & Bernal 2009; Triapitsyn 2012), and *U. ceratus* is also known from *Oncometopia clarior* (Walker 1851) in Mexico [Triapitsyn, Bezark *et al*. 2002 (as *Ufens* sp.)]. *Ufens niger* (Ashmead 1888) was reported from eggs of *C. costalis* and *Homalo-*

disca sp. (Turner & Pollard 1959; Triapitsyn 2003).

***Zagella* Girault, 1918:** The sharpshooter *T. rubromarginata* is a known host of *Z. delicata* De Santis, 1970, its biology was reported by Logarzo *et al*. (2004). Undetermined *Zagella* spp. were also reared from eggs of three other species of Proconiini in Argentina (Paradell *et al*. 2012).

ACKNOWLEDGMENTS

I thank Dr. Hsien-Tzung Shih (TARI, Taiwan) for his kind advice, Dr. Julie Grandgirard (Service du Développement Rural, Papeete, Tahiti, French Polynesia) and Dr. Guillermo A. Logarzo (FuEDEI, Hurlingham, Buenos Aires, Argentina) for collecting the material and making it available for study, Mr. Vladimir V. Berezovskiy (UCRC) for mounting the specimens, and Dr. Douglas Yanega (UCRC) for his review of an early draft.

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法屬大溪地島之 *Anagrus* 屬一新種 (膜翅目：纓小蜂科) 與全球之脊大葉蟬族 (半翅目：葉蟬科：脊大葉蟬族) 卵寄生蜂記述

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摘要

Triapitsyn1, S. V。2013。法屬大溪地島之 *Anagrus* 屬一新種 (膜翅目：纓小蜂科) 與全球之脊大葉蟬族 (半翅目：葉蟬科：脊大葉蟬族) 卵寄生蜂記述。台灣農業研究 62(4):289–299。

褐透翅尖頭大葉蟬 [*Homalodisca vitripennis* (Germar)] 原產於美國東南至墨西哥東北區域，目前已成為法屬波里尼西亞大溪地島的入侵物種。本研究描述採自大溪地島本種葉蟬蟲卵之纓小蜂科一個新種 – 微纓小蜂 [*Anagrus* (*Anagrus*) *iti* sp. n.]，並針對新世界區的脊大葉蟬族之卵寄生蜂 (包括膜翅目的蚜小蜂科、纓小蜂科及赤眼卵蜂科)，提供分類學與生物學的研究回顧。這部份又以傳播植物病原細菌 *Xylella fastidiosa* 最具效力的媒介昆蟲 - 褐透翅尖頭大葉蟬為重點，包括此種葉蟬在非原產地的卵寄生蜂與生物防治之相關研究。

關鍵詞：葉蟬、Proconiini、卵寄生蜂、*Anagrus*、生物防治。

投稿日期：2013 年 7 月 30 日；接受日期：2013 年 9 月 12 日。

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